

NAME P/N QTY	CRIT	FAILURE MODE & CAUSES	FAILURE EFFECT	RATIONALE FOR ACCEPTANCE
LEG RESTRAINT AND BLADDER ASSEMBLY ITEM 104 (1) LEFT (1) RIGHT ----- 0104-810647-02 (2)	2/1RB	104FM28X Loss of fabric restraint. Separation of seam or hole in fabric. Defective thread or restraint material.	END ITEM: Opening in fabric restraint exposing bladder. Loss of restraint circumferential load carrying capability. GFE INTERFACE: Loading and abrading of bladder. MISSION: None for single failure. CREW/VEHICLE: None with single failure. Loss of crewman with loss of bladder. TIME TO EFFECT /ACTIONS: N/A TIME AVAILABLE: N/A TIME REQUIRED: N/A REDUNDANCY SCREENS: A-PASS B-FAIL C-PASS	A. Design - The leg assembly fabric restraint is fabricated from 6.4 ounce dacron fabric which exhibits a minimum tensile strength of 300 lbs/in (warp) and 250 lbs/in (fill). At 4.4 psid (normal operating pressure) the hoop load is 17 lbs/in giving the restraint fabric an ultimate safety factor of 17.6 for warp and 14.7 for fill. At 5.5 psid (max failure pressure) the restraint fabric provides ultimate safety factors of 14.2 for warp and 11.9 for fill. At 8.8 psid (max BTA operating pressure), the restraint fabric provides ultimate safety factors of 8.8 for warp and 7.3 for fill. S/AD minimum safety factors for softgoods at 4.4 psid is 2.0 for ultimate. At both 5.5 psid and 8.8 psid the S/AD minimum safety factors for softgoods is 1.5 for ultimate. The basic seam employed in the construction is one row of join stitching and two rows of top stitching. Seams are formed using size "F" polyester thread per V-T-285D type II, Class I with a lock stitch type 301 per FED-STD-751A. Seams are terminated by backtacking and searing of thread ends. Seam strength, as determined by testing, is equal to or better than the restraint material. A TMG serves to protect the restraint fabric and stitching from abrasion and puncture. There are two types of bladder fabric. One is constructed of a base nylon fabric with a solution coated urethane. The other is constructed of the same base nylon with a urethane laminate coating. The following paragraph applies to the solution coated nylon. Testing has shown that the bladder fabric minimum tensile strength is 105 lbs/inch (fill) and 140 lbs/inch (warp). The tearing strength is 3.5 lbs/inch in fill and 6.0 lbs/inch in warp. Nominally, hoop load is absorbed by the bias direction of the bladder fabric. However, the safety factors are based on the fabric yarns (fill yarns) which have the least strength. Based on a predicted hoop load of 17.2 lbs/inch at 4.4 psid (normal operating pressure), the minimum safety factor for hoop stress is 6.2. At 5.5 psid (max failure pressure) and at 8.8 psid (max BTA operating pressure) the safety factors are 4.9 and 3.0, respectively. The S/AD minimum safety factor for softgoods at 4.4 psid is 2.0. At both 5.5 and 8.8 psid, the S/AD minimum safety factor is 1.5. Testing has demonstrated that the breaking strength of the bladder seams meets or exceeds that of the bladder fabric. The following paragraph applies to the laminate coated nylon. Testing has shown that the bladder fabric minimum tensile strength is 180 lbs/inch in the warp direction and 170 lbs/inch in the fill direction. The tearing strength is 3.5 lbs/inch minimum in both directions. Based on predicted hoop load of 17.2 lbs/inch, the minimum safety factor for hoop stress is 9.8 against a S/AD design minimum ultimate safety factor of 2.0 at 4.4 psid (normal operating pressure). At 5.5 psid (max failure pressure) and at 8.8 psid (max BTA operating pressure) the safety factors are 7.9 and 4.8, respectively. The S/AD minimum safety factor for softgoods at 4.4 psid is 2.0. At both 5.5 and 8.8 psid, the S/AD minimum safety factor is 1.5. Testing has demonstrated that the breaking strength of the bladder seams meets or exceeds that of the bladder fabric. B. Test - Acceptance:

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Component: see inspection.

PDA:

The following test is conducted at the leg level in accordance with ILC Document 0111-710112:

1. Proof pressure test at 8.0 + 0.2 - 0.0 psig with the TMG removed to verify no structural damage.

Certification:

The leg restraint and bladder assembly was successfully tested (manned) during SSA certification to duplicate 458 hours operational life (Ref. ILC Report 0111-711330). The following usage, reflecting requirements of significance to the leg assembly, was documented during certification:

Requirement	S/AD	Actual
Knee Cycles	9078	20000
Don/Doff	98	400
Pressure Hours	458	916
Walking Steps	4320	77760

The leg assembly was successfully subjected to an ultimate pressure of 13.2 psid during SSA certification testing (Ref. ILC Report 0111-711330). This is 1.5 times maximum BTA operating pressure based on 8.8 psid.

C. Inspection -

Components and material manufactured to ILC requirements at an approved supplier are documented from procurement through shipping by the supplier. ILC incoming receiving inspection verifies that the materials received are as identified in the procurement documents, that no damage has occurred during shipment and that supplier certifications have been received which provide traceability information.

MIPs are performed for visual inspection of sewn seams during the leg restraint manufacturing process to assure that this particular failure cause is precluded from the fabricated item.

During PDA, the following inspection points are performed at the leg assembly level in accordance with ILC Document 0111-710112:

1. Visual inspection for fabric or material degradation. Seams are inspected for broken or frayed stitches.
2. Visual inspection for structural damage following proof pressure test conducted with TMG removed.

D. Failure History -

None.

E. Ground Turnaround -

None, for every component within its limited life requirement.

Every 4 years chronological time or 229 hours of manned pressurized time, the leg restraint and bladder assembly is separated from the LTA and subjected to a complete visual inspection (interior and exterior surfaces) for material damage

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and degradation. Following reassembly to the LTA structural and leakage tests are performed.

F. Operational Use -
Crew Response -
PreEVA/PostEVA: Single failure not detectable, no response.
EVA: Single failure not detectable, no response.

Special Training -
No training specifically covers this failure mode.

Operational Considerations -
Not applicable.

EXTRAVEHICULAR MOBILITY UNIT
SYSTEMS SAFETY REVIEW PANEL REVIEW
FOR THE
I-104 LOWER TORSO ASSEMBLY (LTA)
CRITICAL ITEM LIST (CIL)

EMU CONTRACT NO. NAS 9-97150

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